

## Approaches in Teaching “Construction Estimating”

Julie H. Wei, Ph.D., P.E. and Richard K. Sase, P.E.  
California State Polytechnic University, Pomona/  
Main San Gabriel Basin Watermaster

“Estimating” skill is a basic requirement in the construction industry. Typically contractors specialize in one of the following two types of projects: 1) buildings and 2) industrial facilities and heavy civil work. Building construction can generally be classified into residential and commercial projects, and heavy civil construction encompasses a wide range of very different projects involving very large operations. Contractors must be able to prepare estimates that are competitive enough to secure contracts yet allows reasonable profit upon successful completion of the projects. In reality, the success of both contractors and owners of major projects is dependent upon the construction estimating skills of key individuals within a company or an agency. Poorly prepared estimates can lead to distressful results such as financial insolvency and abandoned projects. Many construction graduates start their career as an estimator before moving on to become project engineer, project manager or owner of a construction company.

At California State Polytechnic University, Pomona, students take two estimating courses in their junior year. The first course covers the general aspects of construction estimating fundamentals and practices and the technical details of building construction estimating. The second course focuses on estimating heavy civil construction projects. The following are some of the teaching approaches adopted in these courses.

### **ESTIMATING REQUIREMENTS**

Construction Estimating can generally be broken down into the following phases: 1) Determination of the appropriate construction approaches, 2) Planning, 3) Quantity Take-Off and 4) Pricing. All phases require a thorough understanding of drawings and specifications. A clear understanding in construction methods, equipment and productivity is also required to adopt a cost effective construction approach. Planning is required to ensure efficiency of the estimate process. Quantity Take-Off requires painstaking systematic exercises to determine quantities for all possible work for permanent as well as temporary facilities. Pricing requires a complete and reliable database for direct costs and indirect costs. When unit prices are not readily available, the estimator must be able to perform item analysis using historical data as well as theoretical models to derive unit prices. A good knowledge of general conditions and contract administration is also needed to properly estimate indirect costs. Additionally, understanding of the nature and process of competitive bidding will help in determining the most beneficial profit margin.

In the world of competitive bidding, there are a number of not-so-obvious factors that could affect the way a bid is prepared. A sophisticated contractor can manipulate the unit prices on various bid items and achieve an advantage if the owner’s estimate has been poorly prepared. This situation can arise when the owner’s estimate of quantity for a particular bid item is too low

or if the contractor “knows” that the measured quantity can be manipulated. For the former case, a contractor could bid a higher unit price by proportioning more of the indirect costs to this bid item to gain a competitive edge or to receive more profit. For the latter case, a contractor sometimes may manipulate the quantity of import or export material if the quantity is based on the number of apparently full truckload. The owner’s estimator needs to be aware of such possibilities.

Although not initially apparent to most students, the selection of the “units” used to measure the quantities in a contract can have an impact on the construction results. For example, a residential developer will often prefer to measure the amount of asphalt concrete street pavement on a “per square foot” because the developer wants to minimize the overall cost. Although there is no theoretical difference, the paving contractor will construct the thinnest allowable layer of asphalt concrete pavement if payment is based on the measurement of the surface area. If payment is based on weight of asphalt concrete, the paving contractor will have an incentive to construct the thickest layer of asphalt concrete pavement which is within construction tolerances in order to maximize the payment from owner. Other factors to be considered include owner’s reputation for timely payment, rigidity of inspection requirements, difficulty of traffic control, and expiration of labor contracts.

## **COMPUTER APPLICATIONS**

Certain elements of the estimating process are tedious, repetitious and time consuming. These characteristics make estimating ideal for computer applications. The computer can perform majority of the mundane tasks so the estimator can concentrate on matters that require more of the estimator’s attention. Computer applications have been incorporated in homework and team project assignments. Homework assignments deal with segments of estimating topics while team projects deal with actual project. Students utilize various software programs including Excel (Spreadsheet), Precision Estimating (Timberline proprietary) and Estwrite (Craftsman). In this manner, students have the opportunity to see first-hand the attributes and limitations of various software programs. For team projects, students prepare estimates and write reports using the software of their choice.

## **COLLABORATIVE LEARNING STRATEGIES**

There are numerous factors to be considered in the preparation of quantity and cost estimates. Students are encouraged to think through the impact of these matters when estimate a particular project. Therefore, “Construction Estimating” requires a broad range of knowledge including scope of project, construction methods, equipment needs and risks. Not even a seasoned professional knows all the construction processes or foresees all uncertainties. A good estimate is always a result of the collaborative efforts of many people with different talents and areas of expertise. For students who have either limited or no experience in construction, the task of “Estimating” can be overwhelming although they have previously completed the pre-requisite courses. Further, “Team Work” is a requisite in “Construction Estimating” as well as in other areas of the construction industry. Strategies of collaborative learning have been designed to address these issues.

- **Team Projects**

Project teams are formed and case studies of actual construction projects are analyzed (Exhibit A shows a sample assignment sheet). Students form groups on their own initiative, and each group selects a set of drawings and specifications of an actual project. The group selects its leader and agrees on a working plan and a meeting schedule. They meet regularly to work and discuss the progress and problems associated with the estimate. The group exercises give students the opportunity to take advantage of their very different background, develop teamwork and brainstorming abilities and learn from each other by exchanging experiences. Faculty input is solicited whenever the team deems it needed.

A team project on an actual case study provides a collaborative learning environment and the challenges of reality. The students have taken classes in construction drawing, methods and materials, equipment and accounting before entering “Construction Estimating”. The bulk of actual construction drawings and specifications gives students a preview on what real jobs look like, how drawings are organized, what to look for in drawings and specifications, and how to translate the requirements into costs. The team effort encourages intellectual interactions, generates creative solutions, promotes friendship, and develops the students’ networking skills.

Many students enjoyed the experience, and strong bonds have developed that have extended into professional networking upon graduation. Because friction can develop on occasion due to personality incompatibility or inequity of contribution or level of effort, team project gives students the opportunity to develop skills in inter-personal relations, work planning, conflict resolution, project management and stress management.

Each student is required to perform self-evaluation and peer-evaluation on the fellow team members. Exhibit B shows a sample evaluation form to be completed by the students requiring each student to make a candid review of one’s own performance. It also compels the student to assess the performance of the other members and practice peer evaluation, as professionals (especially those in supervisory positions) must do in industry. It serves as a forewarning about the kind of competition that they will face in future job market. Peer evaluation also makes students accountable for their performance on the team project.

Another goal of the team project is to improve oral and written communication skills. Getting up and speaking to a group is not easy for many people, yet oral communication is very important in construction management. To improve these skills, students make an oral presentation to the class on the overview of the project, challenges of the project, strengths and weaknesses of the estimate and the database. Team members practice and help each other with their presentations to the class.

- **Field Trips**

“ One picture is better than a thousand words!” A visit to a job site is better than a thousand pictures, therefore field trips are scheduled as frequently as possible. In Southern California, there are plenty of construction projects in progress in various stages of construction. Cal Poly Pomona students have always received the utmost cooperation and support from the construction industry. The students have the opportunity to see large construction in progress first hand and to network with professionals in industry. The project engineers and managers usually explain and answer all questions to the fullest extent despite their extremely busy

workload. Students fully appreciate such support and no doubt will follow these role models when they are in such positions in the future.

To get another touch of reality, students sometimes attend a bid opening or visit a contractor's office to observe the actions immediately before bid submittal. At a bid opening, students observe the bidding process and recognize that bid prices sometimes spread over a wide range. At the contractor's office, students notice the ambiance of excitement when subcontractors continue to call in with better prices. The subcontractor tally continues to change and must be checked for meeting bidding requirements. The pinnacle of all the cumulated excitement is the result of bid opening. Students share the joy of being awarded a contract; or, in other cases, the disappointment and the harsh reality of losing.

- **ASC Student Competitions**

To further generate student interest and to build confidence, students are encouraged to participate in the annual student competition sponsored by ASC (Associated Schools of Constructors). Students from various schools of construction gather to participate in a competition that tests the knowledge, skill and endurance. It simulates a real job environment. Typically students prepare estimates, schedules, and bid documents of a real project within a time frame of approximately 20 hours, compared to a contractor who usually has several weeks to prepare the bid. Each school presents its bid and answers questions related to its work. The judges are industry representatives who truly are interested in construction education and will ask a wide range of questions. The annual event allows students to mingle with professionals from the construction industry as well as students from other schools. It also provides an opportunity for students to recognize their strengths and identify areas for improvement.

## **RESULTS**

Students can be very resourceful when given an opportunity to perform. Collaborative learning strategies require professors to assume the roles of facilitator and mentor in addition to being an instructor. The above approaches have been designed to challenge and to prepare students to work in a competitive construction industry in terms of basic skills, computer literacy, team working and understanding of industry practices. They integrate academic theories with industry practices, generate interest of the students, and help provide the industry with valuable new resources. These approaches do require extra effort and time commitments from students, faculty and industry, but the benefits have more than justified the investments.

JULIE H. WEI is Professor of Engineering Technology at the California State Polytechnic University at Pomona.

RICHARD K. SASE is Staff Engineer with the Main San Gabriel Basin Watermaster and is a registered civil engineer and a licensed general building contractor (inactive) in California.

Exhibit A – SAMPLE TEAM PROJECT ASSIGNMENT  
CALIFORNIA STATE POLYTECHNIC UNIVERSITY, POMONA

Team project will be performed by a group of 5 to 6 students. Each group will estimate a set of actual bid documents. It is the group's responsibility to organize and coordinate, to select a group leader, to assign tasks, and to make timely progress.

You may borrow bid documents from the instructor, or you may furnish your own if it is a commercial or industrial project with a construction amount exceeding \$2,000,000 and with prior approval of the instructor. Borrowed document must be kept in good condition and returned to the instructor before the quarter ends.

Each group will perform Budgetary Estimate (square foot and cubic foot estimates) and Detailed Estimate (unit price estimate). The purpose of the Team Project is for students to gain a complete picture of construction estimating including how it relates to other components of a construction project. Detail and precise quantity take-off are not the only objectives of the team project.

Each group will make an oral presentation of project. The final report is due during the ninth and tenth weeks of the quarter immediately after presentation. The final report shall include the following: an evaluation of the team, a condensed summary sheet, price out sheets, quantity sheets, and work sheets in that order. Each sheet must be signed by the responsible parties.

The project evaluation shall include at least the following:

1. Description of project and construction approach.
2. Identification of ambiguity, uncertainty and challenges of project.
3. Explanation of items not included in estimate, and the strengths and weaknesses of your estimate.
4. Evaluation of price books used in your estimate.

Items 1 and 2 are due in a progress report at the 4th week of school.

Each student is required to turn in a completed self-evaluation/peer evaluation form to the instructor at conclusion of the project. A sample evaluation form is attached. Each person is rated in four areas: Preparation, participation, contribution, and leadership. The guidelines are as follows:

1. Preparation

Has the person studied the class material and reading assignments and ready to contribute in a positive manner?

2. Participation

Is the person making a sincere effort to participate in group activities? Is the person a good team player?

3. Contribution

Is the person knowledgeable on the subject? Has the person made valuable contribution to the project?

4. Leadership

Is this person able to step in and organize an activity when the need arises? Is this person well organized? Is this person an effective leader?

Exhibit B—SAMPLE EVALUATION

Course No. \_\_\_\_\_

Project \_\_\_\_\_

Evaluator Name \_\_\_\_\_ Date \_\_\_\_\_

SELF-EVALUATION: (State one's own contribution to the project)

PEER EVALUATION:

Name	Prepara- tion	Partici- pation	Contri- bution	Leader -ship	Total

Score	Description	Limitation ( Person per group)
4	Excellent	one
3	Above Average	two
2	Average	no limit
1	Below Average	no limit
0	Below Minimum requirement	no limit

Additional Comments: